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Working Paper 02-03
June 2002

Room E52-251
50 Memorial Drive
Cambridge, MA 02142

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A Dual Liquidity Model for Emerging Markets

By Ricardo J. Caballero and Arvind Krishnamurthy[1]

January 8, 2002

The last few years have seen a significant re-evaluation of the models used to analyze crises in emerging markets. Recent models typically stress financial constraints or distorted financial incentives. While this certainly represents progress, these models share a weakness with the earlier work: neither is uniquely about emerging markets. Adaptations of the Mundell-Fleming model represent Argentina as a Belgium with larger external shocks. Likewise, emerging market models of financial constraints are adaptations of developed economy ones with tighter financial constraints.

In our work, we have advocated a model which distinguishes between the financial constraints affecting borrowing and lending among agents within an emerging economy, and those affecting borrowing from foreign lenders (Caballero and Krishnamurthy 2001a, b, c). Financial claims on future flows that can be sold to foreign and domestic lenders alike are labeled *international liquidity*, while those that can be sold solely to other domestic agents are labeled *domestic liquidity*. Belgium in our model is a country where most claims are international liquidity, while Argentina is a country where most claims are domestic liquidity.

The dual liquidity model offers a parsimonious description of the behavior of firms, governments, and asset prices during financial crises. It also provides prescriptions for optimal policy responses to these crises. This paper presents a simple sketch of our ideas in a framework akin to the Mundell-Fleming model. The graphical analysis allows us to pose a rich array of questions and illustrates how our answers differ from standard ones. The welfare statements we make below hold up in specifications that are tighter than the model we deploy (see Caballero and Krishnamurthy 2001d).

I International liquidity, domestic liquidity, and crises

Let us simplify matters at the outset and assume that all private investment and public expenditure has to be financed from abroad. That is,

$$I + G = CF$$

where I is domestic investment, G is government expenditures, and CF is net capital inflows. The simplification highlights the impact of external shocks on investment.

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There are two central assumptions in our analysis. The first one regulates the country's access to international financial markets, and the second one determines the functioning of domestic financial markets:

- An external crisis is a situation where CF is not enough to implement the desired levels of $I+G$. We assume that at the time of the crisis, claims on some special future cash flows ("international liquidity") is all that can be sold to foreigners. The country has a stock of international liquidity given by IL, and we require that, $CF \leq IL$, so that

  $$I + G \leq IL.$$

  Loans backed by international liquidity are at the international dollar-rate of i^*.

- Not all of the country's international liquidity is in the hands of those that use it in real investment. The latter need to borrow some of the international liquidity from other domestic agents. Their domestic liquidity or net worth, DL, regulates their borrowing from other domestic agents. DL includes marketable domestic assets, such as real estate and domestic financial assets. We assume that DL is a decreasing function of i^p, the domestic peso-interest rate.[2,3]

Let i^d denote the interest rate faced by a firm when borrowing dollars (international liquidity) from other domestic agents. As we will see, this rate will generally be higher than i_0^* during a crisis.

Under these assumptions, firms' investment is a decreasing function of i^d and i^p. Since firms need to borrow dollars to finance investment, and i^d is the dollar-cost-of-capital, a rise in i^d lowers investment. Tighter monetary policy —that is, an increase in i^p — causes DL to fall, constraining firms ability to borrow:

$$I(i^d, i^p); \qquad \frac{\partial I}{\partial i^d} < 0, \quad \frac{\partial I}{\partial i^p} < 0.$$

Taking i^p and G as given for now, Figure 1a illustrates our modeling of crises. On the horizontal axis is aggregate investment plus government expenditure. The limited international liquidity of the country is represented by the reversed-L shaped supply curve. A crisis is an event when the *quantity* of international liquidity is low relative to investment needs. An external shock decreases the available international liquidity, moving supply to the dashed line and reducing aggregate investment.

$$I(i^d, \bar{i^p}) + G = IL. \tag{1}$$

[2]See Caballero and Krishnamurthy (2001d) for a model connecting domestic liquidity, monetary policy, and investment.

[3]Ben Bernanke and Alan Blinder (1988) also outline a model in which there are two forms of liquidity: bonds and bank-loans. However in their case the two liquidities are substitutes. In contrast, in our model there is a hierarchy: IL is ultimately what is needed for investment, while DL serves only to aggregate the IL of the economy.

In this crisis equilibrium, domestic firms finance investment by selling their domestically liquid assets in exchange for international liquidity. The price of the limited international liquidity (i^d) rises above i_0^* to clear the market. Foreign investors do not arbitrage the difference of $i^d - i_0^*$ because they are unwilling to exchange international liquidity for domestically liquid assets.

In contrast, the lower panel represents a standard modeling of crises. The usual small-open-economy assumption means that the supply of dollars is elastic at the international interest rate. The external shock is a rise in the interest rate (or risk premium) that raises i^d from i_0^* to the dashed line (i^*). Since the interest rate on borrowing dollars rises, investment falls.

While for an appropriate rescaling the external shock leads to the same equilibrium levels of i^d and I than in the dual liquidity economy, the fact that the supply of international funds is inelastic at the equilibrium point in the latter has important ramifications for what follows.

II Domestic interest parity condition

Let us now see how i^d affects domestic asset prices. Consider the marginal domestic investor in the crisis equilibrium of Figure 1a with a unit of international liquidity (say, one dollar). There are two options available to the agent. The first is to lend this to a domestic firm and earn interest at the rate of i^d one period hence. The second is to convert the dollar into pesos, at the exchange rate of e and invest these pesos in a domestic bond to earn interest of i^p. Fixing the future exchange rate at $\bar{e}$, and since the agent must be indifferent in equilibrium between the two strategies, we obtain a *domestic* interest parity condition:

$$1 + i^d = \frac{e}{\bar{e}}(1 + i^p).$$

Rewriting and dropping the higher order term, we arrive at:

$$i^d \approx i^p + \hat{e}, \tag{2}$$

where $\hat{e} \equiv e/\bar{e} - 1$, is the expected appreciation of the domestic currency. A rise in i^d, as in the external shock of Figure 1a, causes the exchange rate to depreciate in order to yield an expected appreciation. Alternatively, the monetary authority may defend the currency by raising the domestic interest rate of i^p.

If we replace the domestic bond in the previous argument with any (only) domestically liquid asset, then the rise in i^d will result in the dollar-price of that asset to fall. The model thus provides a simple account of the fall in domestic asset prices and exchange rate depreciations accompanying external crises.

It is also worth noting that the fall in domestic asset prices is due to an aggregate shortage of international liquidity, as opposed to a problem of domestic assets – i.e. the price of real estate falls not because real estate will generate less revenues in the future, but due to limited IL.

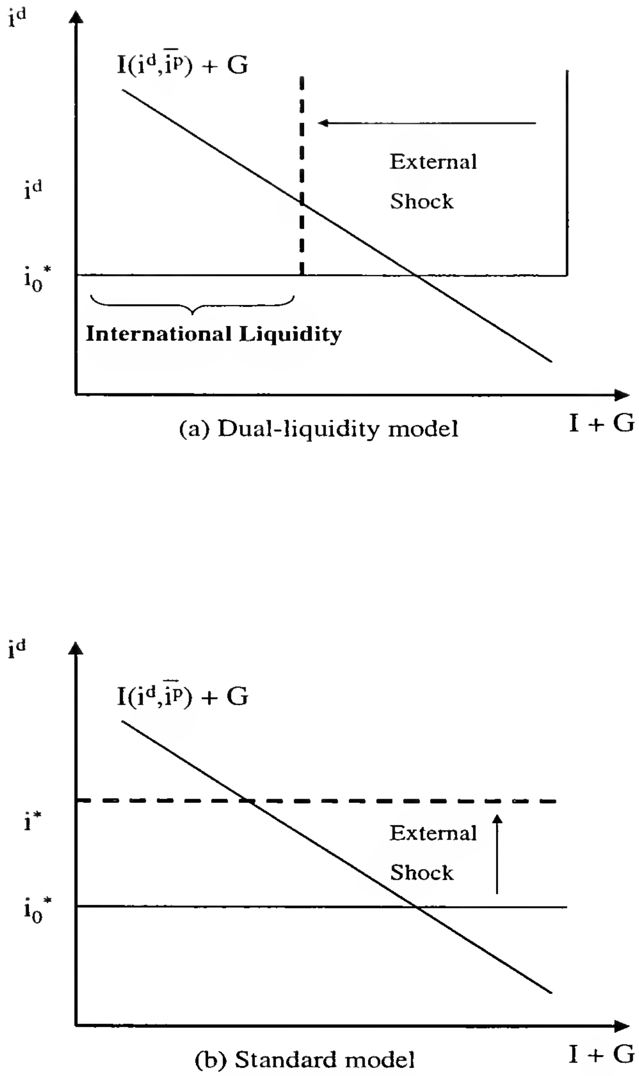

Figure 1: External Crises

III LM curve and Equilibrium

The peso-interest rate i^p is determined by a (nearly) conventional LM curve,

$$L(\overset{-}{i^p}, I \overset{+}{+} G) = M, \tag{3}$$

where we have used nominal money stock on the right-hand-side, as opposed to $\frac{M}{P}$ or $\frac{M}{e}$. Using real money stock does lead to some interesting issues when the central bank post-crisis inflation target is not credible (see Caballero and Krishnamurthy, 2001d). But, for present purposes, it only complicates the analysis.

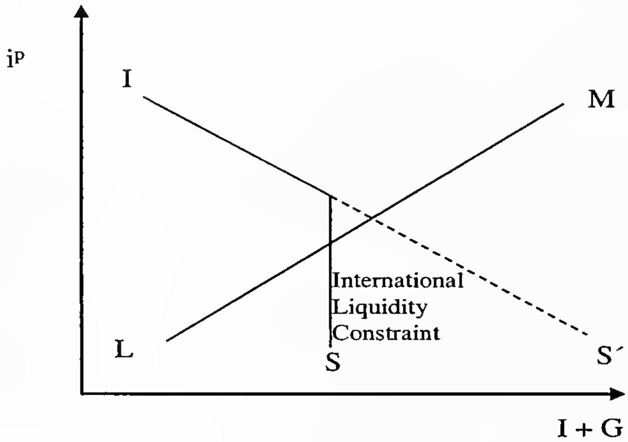

Figure 2: Equilibrium

Figure 2 depicts the equilibrium of (1) and (3). The curve IS' corresponds to a case where international liquidity is not scarce, while the dual liquidity model is represented by IS. The international liquidity is constrained in the vertical segment of the IS curve, and $I + G$ is determined by IL as opposed to i^p. Figure 2 along with Figure 1a describe the equilibrium of $(I + G, i^d, i^p)$. Combined with (2), this also describes the exchange rate.

IV Monetary policy

From the IS' curve we note the standard effect of monetary policy in models with financial constraints. An expansion in money, shifts out the LM curve, lowering i^p. The latter raises firms' net worth and thereby relaxes their domestic financial constraint and facilitates investment.

In our modeling of crises (IS), this logic does not apply. Monetary policy has no contemporaneous effect on investment. This is because we assumed that at the aggregate level investment was dependent only on IL during the crisis.

If we imagine an experiment where we increased the DL of a single firm, holding all other firm's DL fixed, it will be true that this firm's investment will raise. The firm will sell its extra DL for some IL and thereby increase its real investment. However, lowering i^p has the effect of increasing all firm's DL. Since in aggregate IL is fixed, this action will only bid up the domestic price of international liquidity. It will shift up the $I(i^d, \bar{i^p})$ curve in Figure 1a, and raise i^d.

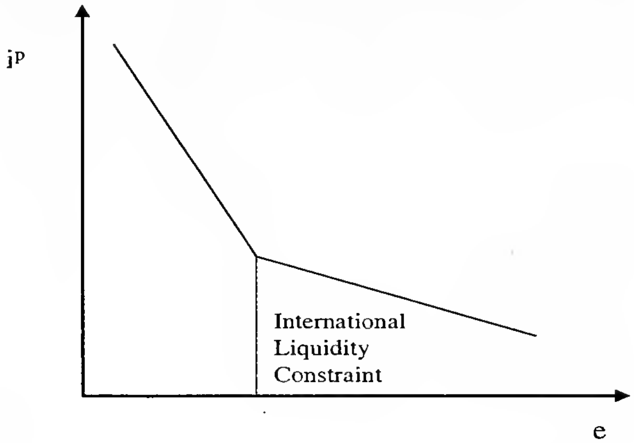

Figure 3: Interest and Exchange Rate

Figure 3 illustrates the impact of monetary policy on exchange rates in our model. First, from (2), lowering i^p while holding i^d fixed leads to the standard exchange rate depreciation. This is the first segment in the downward-sloping curve. However, in our model, when IL is constrained, lowering i^p also causes i^d to rise. This *shift* in the domestic interest-parity condition reinforces the exchange rate depreciation. Thus the curve becomes flatter at this point (the second segment). [4]

These last observations lead to an insight regarding monetary policy: If rather than expanding, the central bank tightens monetary policy during a crisis, it does not reduce investment further, but it does alleviate the exchange rate depreciation that a crisis-high i^d would bring about. If the monetary authority is at all concerned about meeting an exchange rate/inflation target, it will tend to tighten monetary policy during a crisis. Thus our model rationalizes "fear of floating" as a positive description of central banks behavior in emerging markets (see Guillermo Calvo and Carmen Reinhart, 2000).

[4] An interesting detour is obtained if we write the international liquidity constraint as $I + G = IL(e)$. This is the case where devaluations may increase exports that count as international liquidity. In this case, loosening monetary policy depreciates the exchange rate and increases output, via relaxing the external constraint. On the other hand, one may also believe that DL is decreasing in e, perhaps because firm's have a substantial amount of dollar debt, so that devaluations decrease their net worth. In this case, the opposite conclusion may obtain if the decline in DL is sharp enough so that the country ends up wasting aggregate international liquidity (see Caballero and Krishnamurthy 2001b).

V Fiscal policy

The model's implication for fiscal policy are also worth highlighting. In the standard Mundell-Fleming setup, an expansionary fiscal policy (right-shift in IS') raises i^p and in the process partially crowds out I. The rise in the peso-interest rate appreciates the exchange rate.

In the dual liquidity economy, fiscal policy competes with the private sector for *international* liquidity, and since IL is fixed it crowds out private investment one-for-one. An expansionary fiscal policy has no effect on the vertical part of IS. The competition for IL raises i^d rather than i^p. As a result, the domestic interest parity condition shifts from the (new) kink to the right and causes a *depreciation* of the exchange rate (see Figure 4).

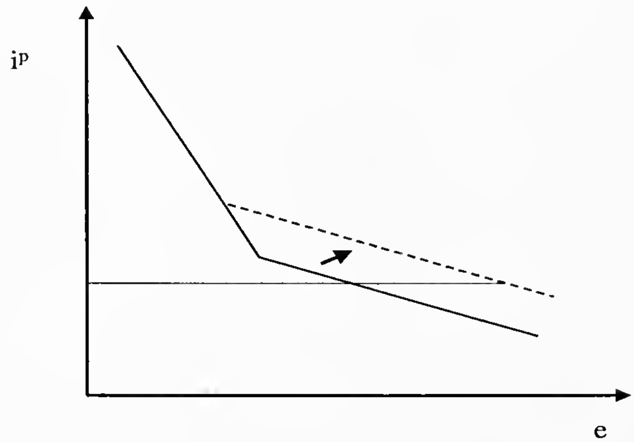

Figure 4: Expansionary Fiscal Policy

The differences are even starker in a *fixed exchange rate regime*. In the standard model, fiscal policy is potent because it is reinforced by an endogenous expansion in monetary policy: The rise in i^p tends to appreciate the exchange rate, which is offset only by a monetary expansion. In contrast, in the dual liquidity model the exchange rate tends to depreciate as a result of the fiscal expansion since i^d rises, and hence monetary policy will have to tighten to preserve the peg.

VI Overborrowing and Ex-ante Policy Options

During a crisis, the stock of IL fully determines investment. Let us imagine shifting prior to the crisis, to a point in time where private and central bank actions may influence this stock. We will discuss two actions that may affect IL: private external borrowing, and central bank reserve accumulation. Define IL_0 as the initial international liquidity, D_0 as external debt, and R_0 as foreign reserves accumulated. Normalizing the world gross interest

rate to one, we have

$$IL = IL_0 - D_0 + R_0.$$

A private agent contemplating taking on some external debt and importing goods faces a tradeoff: Importing goods increases consumption or investment today, but reduces IL that would otherwise relax the aggregate investment constraint during the crisis. The agent values the latter benefit at i^d. We have shown elsewhere (see Caballero and Krishnamurthy, 2001a) that when domestic financial markets are underdeveloped there is an externality – akin to a free-rider problem – whereby the market value of this benefit, i^d, is less than its social value. In this circumstance, the private sector overborrows and arrives at a crisis with too little IL.

There are three basic instruments at the Central Bank's disposal to offset the tendency of the private sector. First, it can increase foreign reserves (R_0) and thereby increase IL. Our model provides a natural motivation for both centralized holding of reserves, as well holding them in the form of international liquidity. One concern here is that, in some circumstances, increasing R_0 may in turn exacerbate the external overborrowing problem and raise D_0 (see Caballero and Krishnamurthy 2001c). Second, it can tax capital inflows and directly reduce D_0, so as to increase IL. Of course, taxes may lead to other distortions. Third, and most interestingly, it can commit to *expand* monetary policy during the crisis — just the opposite as it will be inclined to do during the crisis. Since lowering i^p during the crisis raises i^d, it increases the private sector's valuation of IL and alters the private sector's borrowing incentives.

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